

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
25 July 2002 (25.07.2002)

PCT

(10) International Publication Number  
**WO 02/057228 A1**

(51) International Patent Classification<sup>7</sup>: **C07D 207/34,**  
A61K 31/40, A61P 3/06

20th K.M. Hosur Road, Hebbagodi, Bangalore 561 229,  
Karnataka (IN).

(21) International Application Number: PCT/IN01/00004

(74) Agents: **ANAND, Pravin** et al.; Anand & Anand, B-41  
Nizamuddin East, New Delhi 110 013, Maharashtra (IN).

(22) International Filing Date: 17 January 2001 (17.01.2001)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): **BIOCON  
INDIA LIMITED** [IN/IN]; 20th K.M Hosur Road, Heb-  
bagodi, Bangalore District, Bangalore 561 229 (IN).

(81) Designated States (national): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,  
DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR,  
HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,  
LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ,  
NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM,  
TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

**Published:**

— with international search report

(72) Inventors; and

(75) Inventors/Applicants (for US only): **JOY, Mathew**  
[IN/IN]; Mathew Joy, 20th K.M. Hosur Road, Hebbagodi,  
Bangalore 561 229 (IN). **GANESH, Sambasivam** [IN/IN];

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: **ATORVASTATIN CALCIUM**

(57) Abstract: A process for the preparation of amorphous atorvastatin calcium and its hydrates thereof which comprises: (a) dis-  
solving heterogeneous mixture of atorvastatin calcium in a non-hydroxylic solvent; (b) adding a non-hydroxylic solvent or adding the  
dissolved atorvastatin to the non-hydroxylic solvent to precipitate out atorvastatin calcium; and (c) removing the solvent by filtration  
to afford amorphous atorvastatin calcium.



**WO 02/057228 A1**

**EXPRESS MAIL NO. EV545395338US**  
**DOCKET NO. PC25264A**

## ATORVASTATIN CALCIUM

### FIELD OF THE INVENTION

The present invention relates to a process for the production of amorphous atorvastatin calcium.

### BACKGROUND OF THE INVENTION

The process for the production of amorphous [R-(R\*,R\*)]-2-(4-fluorophenyl)- $\beta$ , $\delta$ -dihydroxy-5-(1-methylethyl)-3-phenyl-4-[(phenylamino)carbonyl]-1H-pyrrole-1-heptanoic acid hemi calcium salt.

Atorvastatin calcium, a synthetic HMG-CoA reductase inhibitor, is used for the treatment of hyperlipidemia and hypercholesterolemia, both of which are risk factors for arteriosclerosis and coronary heart disease.

United States Patent 5,273,995, describes that R-form of the ring opened acid form inhibits the biosynthesis of cholesterol.

Atorvastatin in its calcium salt form, i.e. amorphous [R-(R\*,R\*)]-2-(4-fluorophenyl)- $\beta$ , $\delta$ -dihydroxy-5-(1-methylethyl)-

3-phenyl-4-[(phenylamino)carbonyl]-1H-pyrrole-1-heptanoic acid hemi calcium salt (2: 1) is discussed in literature.

Various United States patents like, 5,003,080; 5,097,045; 5,103,024; 5,124,482; 5,149,837; 5,248,793; 5,280,126; 5,342,952, which are herein incorporated by reference, describe various processes and key intermediates for preparing atorvastatin calcium.

The process mentioned in the above patents does not produce atorvastatin calcium in its amorphous form consistently. Often a mixture of crystalline and amorphous form is obtained which is not suitable for filtration and drying and therefore not a desirable process for large-scale production.

PCT application, WO 97/03959, discloses novel crystalline forms of atorvastatin calcium designated as Form I, Form II, and Form IV and method for their preparation. PCT application WO 97/03960 describes a procedure for converting the crystalline form of atorvastatin to the amorphous form.

The process described in the above mentioned patent involves dissolving the crystalline atorvastatin (form-I) in a non hydroxylic solvent like tetrahydrofuran or mixtures of tetrahydrofuran and toluene, followed by removal of the

solvents under high temperature (about 90°C) and high vacuum (about 5mm). This process may not be suitable on a large scale as the conditions used for drying may lead to degradation of the product.

PCT application WO 00/71116 claims a process for the preparation of amorphous atorvastatin calcium where the crystalline form is dissolved in a non-hydroxylic solvent is treated with a non-polar hydrocarbon anti-solvent followed by the removal of the solvent to result in the amorphous form.

## **SUMMARY OF THE INVENTION**

It is desirable to have a process, which provides amorphous atorvastatin using a procedure, which can be readily scaled up to a commercial scale. The present invention describes a process, which is ideal for large scale production of amorphous atorvastatin calcium.

The present invention provides a process for the preparation of atorvastatin calcium in an amorphous form which comprises dissolving the heterogeneous mixture of atorvastatin in a non-hydroxylic solvent followed by the addition of a suitable non-hydroxylic solvent to precipitate the product which is then isolated. Alternatively, the solution of atorvastatin in a non-

hydroxylic solvent is added to a non-hydroxylic solvent to induce precipitation.

The product can be isolated by any method known in the art such as by filtration, centrifugation or decantation. Typically, this product is isolated by filtration when any of the solvents within the scope of the process are used.

Major advantages of the present invention compared to the prior art processes are:

- i. Produces amorphous atorvastatin consistently.
- ii. Avoids the necessity to remove solvents.
- iii. Simpler and faster filtration.
- iv. Easy to operate on large-scale.
- v. Avoids the use of hydrocarbons.

The present invention thus provides a simple and novel process for the preparation of amorphous atorvastatin calcium and hydrates thereof. The starting material used in the instant invention comprises of a mixture of both amorphous and crystalline forms – henceforth referred to as heterogeneous mixture. The present invention comprises of:

- (i) Dissolving the heterogeneous mixture of atorvastatin calcium in a non-hydroxylic solvent;

- (ji) Adding a non-hydroxylic solvent to precipitate the material;  
and
- (iii) Removing the solvent by filtration to afford amorphous atorvastatin calcium.

The non-hydroxylic solvent in step (i) is tetrahydrofuran.

The non-hydroxylic solvent used in step (ii) is diisopropyl ether.

The amorphous atorvastatin calcium is isolated by filtration.

Amorphous atorvastatin calcium prepared according to the process of the present invention may be characterized by its x-ray powder diffraction pattern (Figures 2) as shown in the accompanied drawings. X-ray powder diffraction patterns (Figures 2) show no peaks which are characteristic of a heterogeneous mixture of atorvastatin calcium (Figure 1 of the accompanied drawings) thus demonstrating the amorphous nature of the product.

## **BRIEF DESCRIPTION OF THE FIGURES**

Figure 1 is the diffractogram of heterogeneous mixture of atorvastatin calcium. The horizontal axis represents  $2\theta$  and the vertical axis corresponds to peak intensity.

Figure 2 is the diffractogram of amorphous atorvastatin calcium. The horizontal axis represents  $2\theta$  and the vertical axis corresponds to peak intensity.

The present invention is illustrated by the following examples, which are intended to limit the effective scope of the claims.

## DETAILED DESCRIPTION OF THE INVENTION

### Example 1

**[R-(R\*,R\*)]-2-(4-fluorophenyl)- $\beta$ , $\delta$ -dihydroxy-5-(1-methylethyl)-3-phenyl-4-[(phenylamino)carbonyl]-1H-pyrrole-1-heptanoic acid hemi calcium salt (Amorphous Atorvastatin calcium).**

A heterogeneous mixture of Atorvastatin calcium (10 g) was dissolved in tetrahydrofuran (200 ml) at 55°C and filtered over hyflo supercell. The filtrate was evaporated to 40 ml stage under vacuum and precipitated using diisopropyl ether (200 ml) at room temperature. The mixture was stirred for 30 min. at room temperature and filtered. The product was washed with diisopropyl ether (15 ml). The product was dried in vacuum tray drier (650 mm/Hg) at 55°C for 24 hrs to yield 9 g.

X-ray powder diffraction pattern (Figure 2 as shown in the accompanied drawings) demonstrates the amorphous nature of the product as against the heterogeneous nature of the starting material (Figure 1 as shown in the accompanied drawings)

While the present invention has been described in terms of its specific embodiments, certain modifications and equivalents will be apparent to those skilled in the art and are intended to be included within the scope of the present invention.



**WE CLAIM:**

1. A process for the preparation of amorphous atorvastatin calcium and hydrates thereof which comprises:
  - (i) dissolving heterogeneous mixture of atorvastatin calcium in a non-hydroxylic solvent;
  - (ii) adding a non-hydroxylic solvent or adding the dissolved atorvastatin to the non-hydroxylic solvent to precipitate out atorvastatin calcium; and
  - (iii) removing the solvent by filtration followed by drying to afford amorphous atorvastatin calcium.
2. The process as claimed in claim 1, wherein the non-hydroxylic solvent in step (i) is tetrahydrofuran.
3. The process as claimed in claim 1, wherein the non-hydroxylic solvent used in step (ii) is diisopropyl ether.
4. The process as claimed in claim 1, wherein said amorphous atorvastatin calcium is isolated by filtration.
5. The process as claimed in claim 1 wherein said heterogeneous mixture of atorvastatin calcium comprises a mixture of both amorphous and crystalline forms.

Figure 1

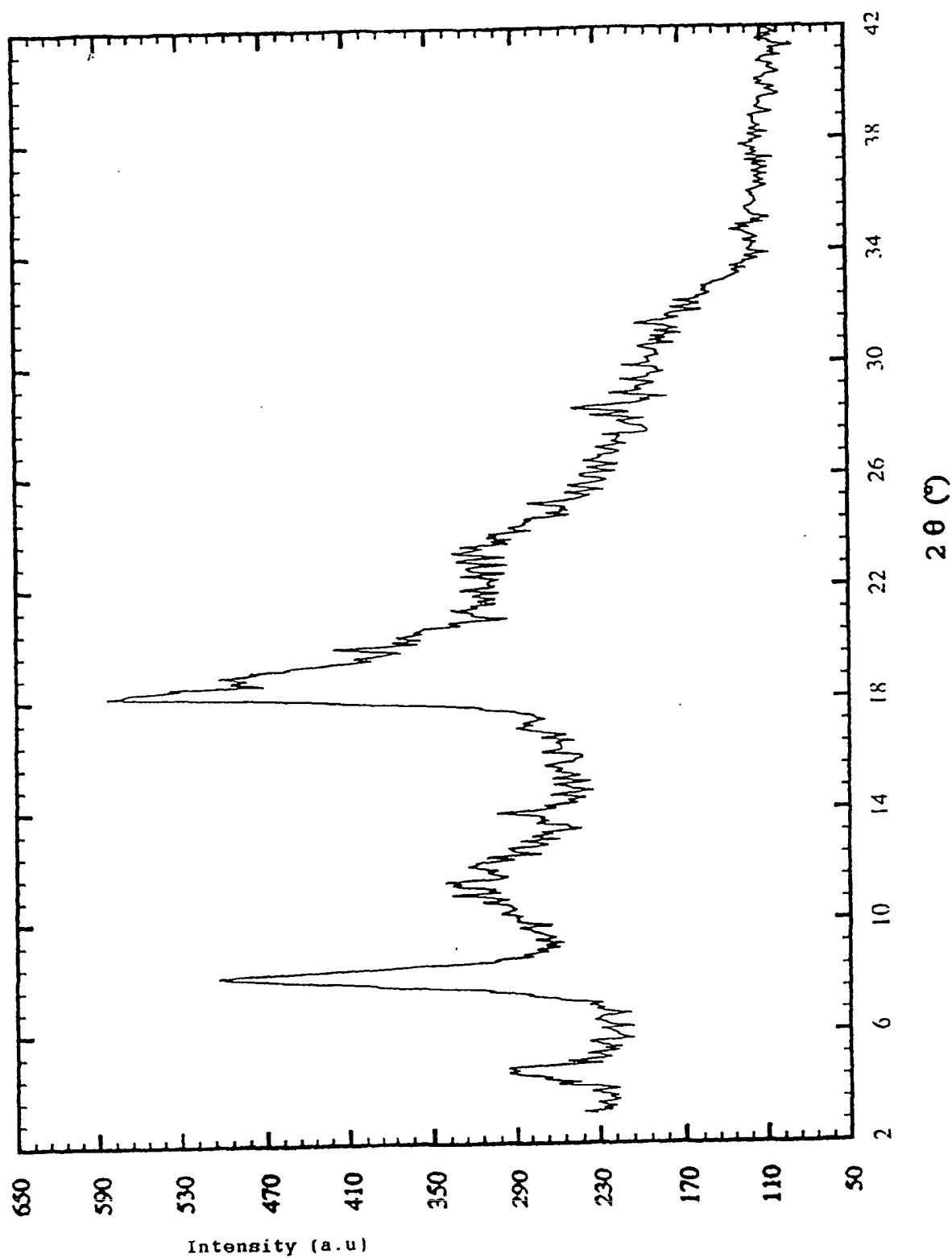
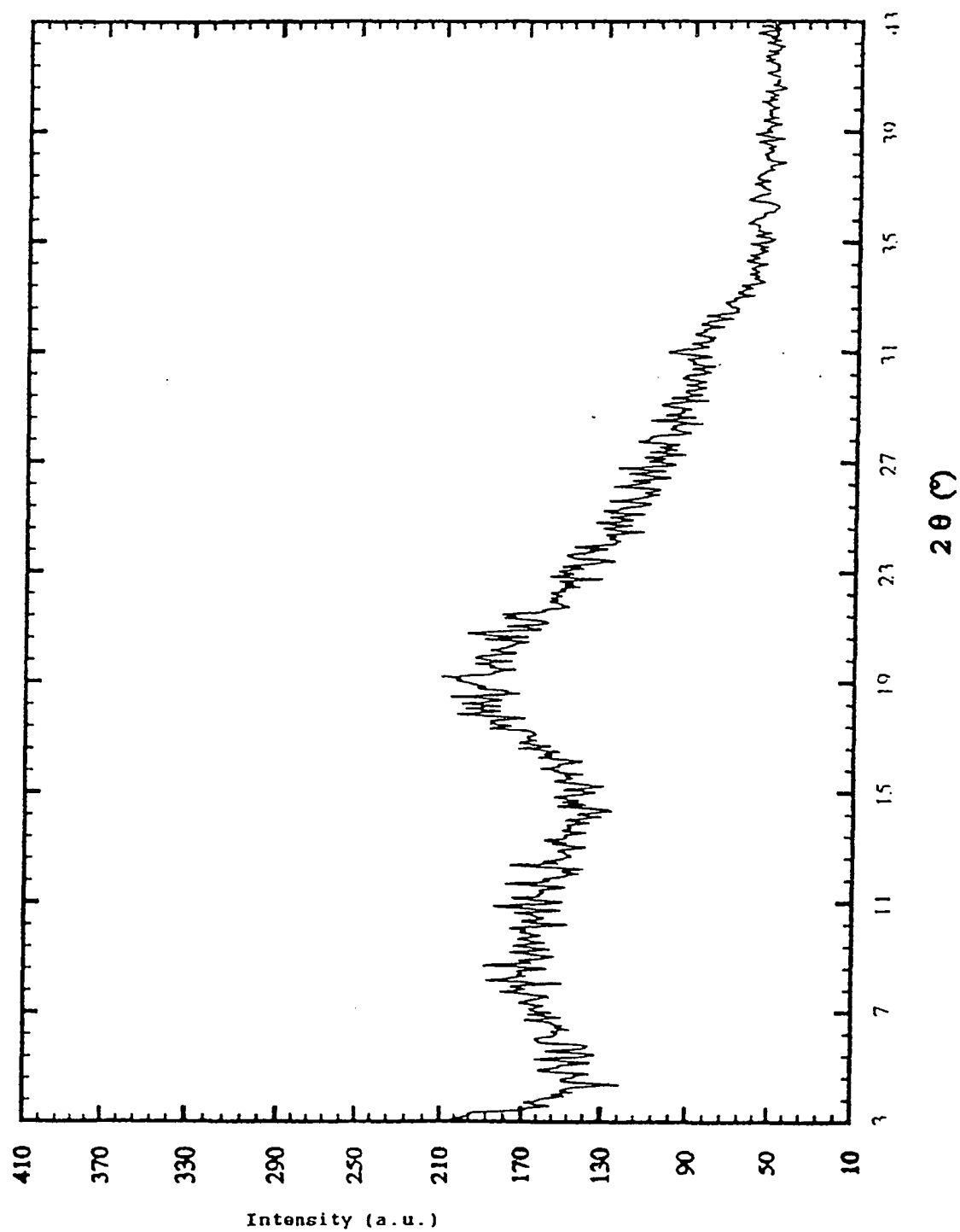


Figure 2



## INTERNATIONAL SEARCH REPORT

ational Application No  
ru/IN 01/00004

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 C07D207/34 A61K31/40 A61P3/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 C07D A61P A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, CHEM ABS Data, BEILSTEIN Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 71116 A (THAPER RAJESH KUMAR ;KUMAR YATENDRA (IN); RANBAXY LAB LTD (IN); KU) 30 November 2000 (2000-11-30) cited in the application claims 1-6	1,2,4
A	WO 97 03960 A (WARNER LAMBERT CO ;LIN MIN (US); SCHWEISS DIETER (US)) 6 February 1997 (1997-02-06) cited in the application claims 1,2	1
A	US 5 385 929 A (BJORGE SUSAN M ET AL) 31 January 1995 (1995-01-31) example 2	1
	--- -/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*G\* document member of the same patent family

Date of the actual completion of the international search

17 September 2001

Date of mailing of the international search report

25/09/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Seitner, I

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/IN 01/00004

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	BAUMANN K L ET AL: "THE CONVERGENT SYNTHESIS OF CI-981, AN OPTICALLY ACTIVE, HIGHLY POTENT, TISSUE SELECTIVE INHIBITOR OF HMG-COA REDUCTASE" TETRAHEDRON LETTERS, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, vol. 33, no. 17, 21 April 1992 (1992-04-21), pages 2283-2284, XP000608147 ISSN: 0040-4039 the whole document -----	1
E	WO 01 42209 A (LEK TOVARNA FARMACEVTSKIH ;PFLAUM ZLATKO (SI)) 14 June 2001 (2001-06-14) claim 1; examples 1-5 -----	1-5

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/IN 01/00004

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0071116	A	30-11-2000	AU 1996700 A WO 0071116 A1	12-12-2000 30-11-2000
WO 9703960	A	06-02-1997	AT 199542 T AU 700794 B2 AU 6497896 A BG 102188 A BR 9609714 A CA 2220455 A1 CN 1190956 A CZ 9800122 A3 DE 69611999 D1 DE 69611999 T2 DK 839132 T3 EE 9700369 A EP 0839132 A1 ES 2156997 T3 HR 960312 A1 IL 122161 A JP 11510486 T NO 980209 A PL 324463 A1 PT 839132 T SI 839132 T1 SK 5898 A3 WO 9703960 A1 US 6274740 B1	15-03-2001 14-01-1999 18-02-1997 31-08-1998 23-02-1999 06-02-1997 19-08-1998 16-12-1998 12-04-2001 26-07-2001 09-04-2001 15-06-1998 06-05-1998 01-08-2001 28-02-1998 14-07-1999 14-09-1999 16-01-1998 25-05-1998 29-06-2001 30-06-2001 05-08-1998 06-02-1997 14-08-2001
US 5385929	A	31-01-1995	EP 0680963 A1 JP 7304735 A	08-11-1995 21-11-1995
WO 0142209	A	14-06-2001	SI 20425 A WO 0142209 A1	30-06-2001 14-06-2001